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Introduction to Passive Safety

Subject **Page**

Initial Print Date: 12/04 Revision Date:

Introduction to Passive Safety

Model: All with Passive Safety Systems

Production: All

OBJECTIVES

After completion of this module you will be able to:

- Understand the History of BMW Passive Safety
- Understand the differences between Passive and Active Safety
- Understand the concepts behind F.I.R.S.T.
  (Fully Integrated Road Safety Technology)

Introduction

History of BMW Safety Systems

BMW has a long history of being at the forefront of passenger safety technology. Before the introduction of airbag systems, seatbelts provided the primary restraint for protection of the occupants during an impact. Three point seatbelts provided the greatest level of occupant safety at that time.

Many other safety innovations were already is use before airbag systems were introduced. Energy absorbing body structures with “crumple zones” uphold the integrity of the passenger safety cell. Some of the other features are “breakaway” engine and transmission mountings, collapsible steering column, door mounted impact beams and a hood that is designed to fold on impact rather than penetrate the windshield.

There are many other safety innovations which are transparent to the driver, but are crucial to providing a safe environment for the vehicle occupants.

Since 1986, when BMW first introduced the Supplementary Restraint System (SRS) to their US model line, BMW has continuously improved the level of occupant protection.

The driver’s side airbag was standard on all US production models from 1986. Later, the passenger side airbag became standard on the 1992 models.

These first systems were made by Cipro and Siemens and consisted of mechanical crash sensors located on the inner fenders. An airbag was mounted on the steering wheel and a control unit containing a mechanical safing sensor was located in the passenger compartment. The vehicle wiring harness was modified to accommodate these systems.

Later versions included a standard passenger side airbag from 9/91 production. These system were designated Siemens 2C. These systems were replaced by ZAE.

Beginning with the 1994 model year, the ZAE system was introduced on US models. The E31, E34, E36 and E38 all used the ZAE I system. ZAE I used crash sensors which were integral to the control unit and eliminated the mechanical fender mounted sensors on previous models. Also the passenger seat occupancy detection system (SBE) was introduced at this time. ZAE 2 was introduced later and now included the detection of rear impacts.

The Multiple Restraint System (MRS) addressed the need for side impact protection. Starting with the E39, door mounted side airbags were added on the front driver and passenger side. The MRS system also utilized side impact sensors which were externally mounted near the b-pillar. In combination with the MRS control unit, the side impact sensors allowed the MRS system to differentiate between front, rear and side impacts.

Subsequent versions of MRS introduced new technology and enhancements to MRS I. MRSII utilized the new head protection system (HPS) and also the new Safety Battery Terminal.

MRS III has new features including the 2-stage airbag and the rear head protection system. Also, the MRS III control unit was now connected to the K-bus for diagnosis, improved crash signalling and for the fuel pump cut-off feature.

The only changes to MRS IV were improved software and triggering algorithms. It was introduced in 4/01 production on the E46 and E53 and later phased into E38 and E39.

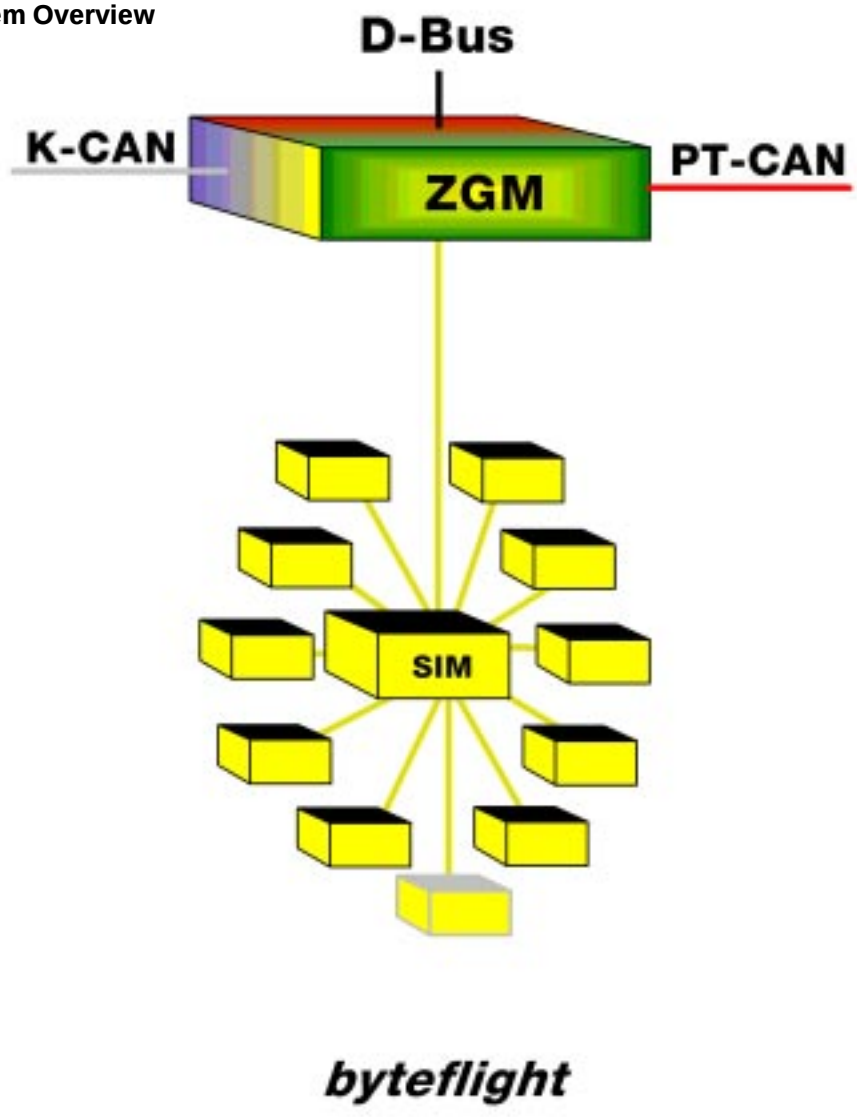
The latest version of MRS is the MRS4RD system. The “RD” designation indicates a redesign over the previous MRSIV system. Numerous modifications include additional crash sensors mounted in the front of the vehicle and pressure sensors mounted in the front doors. Also, the new passenger seat occupancy detection system (OC-3) which is capable of determining the approximate size of the occupant based on weight distribution. To accommodate these changes, the MRS control unit was increased to 75 pins from the previous 50 pin control unit.

E83 with MRS4RD

The introduction of the E65 brought about a new era in passive safety technology. The new passive safety system on the E65 was a departure from the MRS philosophy. Instead of having the triggering electronics located centrally in the MRS module. The new method was to decentralize the triggering electronics by locating the trigger circuits in the satellite sensors which are closer to potential impact points.

The new system is referred to as the Intelligent Safety and Information System (ISIS). ISIS consists of a series of satellites connected by an optical bus network called ***byte-flight***. The ***byteflight*** network was specifically designed a a high speed network for use on safety related systems.

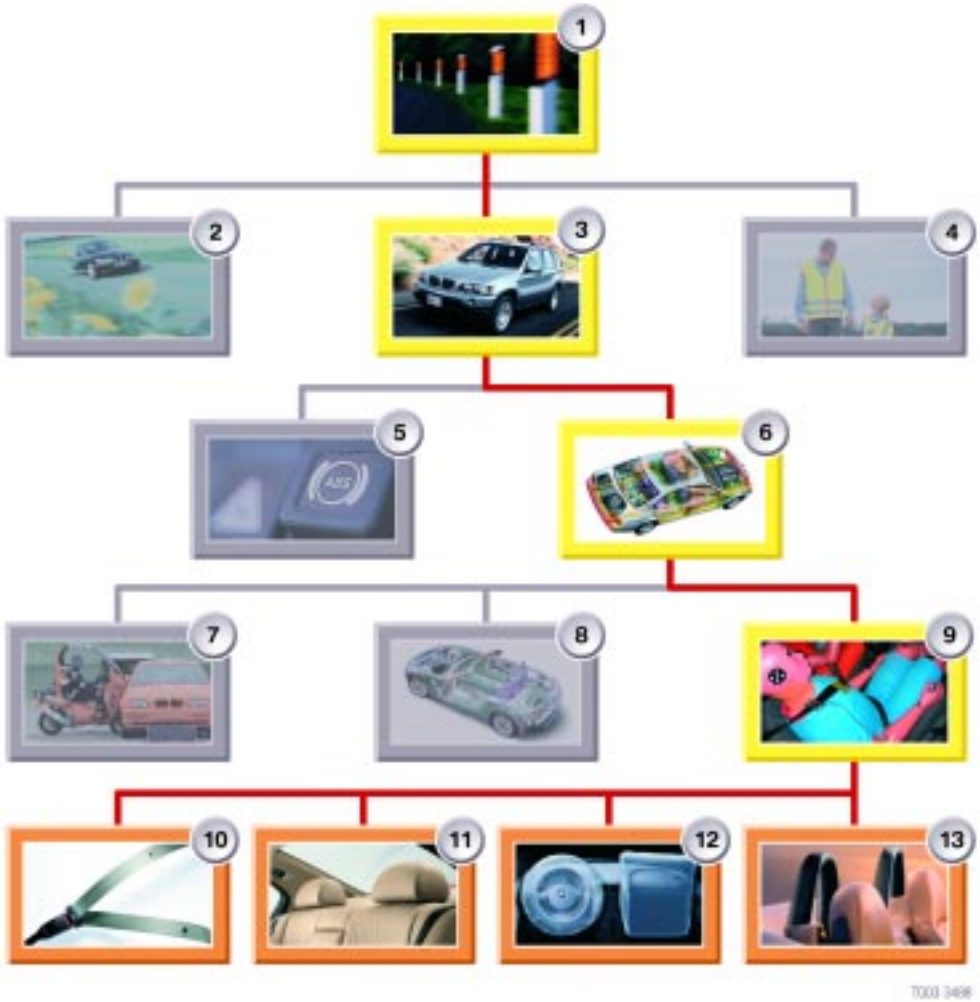
E65 ISIS System Overview



The ISIS concept was also adopted on the new Advanced Safety Electronic (ASE) systems which was introduced on the E85. The ASE system is also used on the new E60, E63 and E64 vehicles. ASE is similar in design to ISIS, and uses the byteflight fiber optic network. However the total number of satellites is reduced as compared to ISIS.

Fully Integrated Road Safety Technology (F.I.R.S.T.)

The BMW FIRST safety concept incorporates the environmental considerations (traffic, road conditions), the vehicle (active and passive safety), and the people involved. During the design process, all of these things are taken into to consideration to create a safe environment for the passengers as well as considering the durability of the vehicle during an impact to comply with federal law and insurance regulations.



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F.I.R.S.T. is the cornerstone behind BMW's safety philosophy. This technology consists of *active* and *passive* safety features designed to help the driver avoid accidents as well as protect the occupants in the event of an unavoidable accident.

Active Safety features are designed to help the driver avoid accidents. In other words these features allow the driver to actively avoid potentially dangerous situations. These features consist of consist of a responsive engine, stable suspension, precise steering and excellent all around vision. Systems such as Dynamic Stability Control (DSC) and ABS also help the driver retain precise control of the vehicle.

Traffic and adverse environmental conditions can be offset by systems such as RLS (rain sensing wiper control), X-Drive, climate control with mist sensor and driving lights etc.

Other features which are "transparent" to the driver include the multi-function steering wheel which allows the driver to control the cruise control and audio systems while still focusing on the road. The seating position and location of switches and controls are also taken into consideration during the design process. The new HUD also allows the driver to access important driving information while maintaining concentration.

Passive Safety features provide vehicle occupant protection when an accident cannot be avoided. Today's BMW Passive Safety systems consist of the following features:

- Energy absorbing body structures
- Seatbelts with Automatic tensioners and force limiters
- Dual front airbags with 2-stage deployment
- Head Protection Systems (front as well as rear on some models)
- Side Impact Airbags (standard) and Rear Side Airbags (optional)
- Active Knee Protection Airbags (On some models)
- Battery Safety Terminal
- Active Head Restraints (on some models)
- Rollover Protection on Convertibles (E36, E46 and E64) and fixed rollover bars on the Z3 and Z8 and Z4.

Energy Absorbing Body Structures

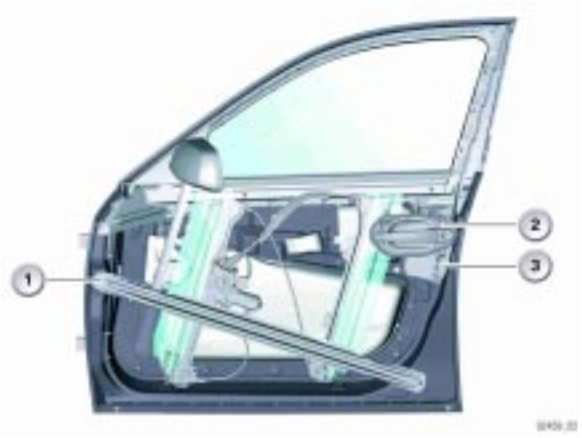
One of the first considerations in designing a safe vehicle is the body and chassis design. It is vital to protect the passenger in the event of an impact. This is accomplished by maintaining the integrity of the “passenger cell” during an accident.

The main consideration during an impact is to avoid transferring crash energy to the vehicle occupants. By adding energy absorbing crash elements to the vehicle, this energy transfer is reduced considerably.

Passenger Safety Cell E60

In addition to having energy absorbing structures in the front and rear of the vehicle, there are also side impact protection structures in the doors. These structures not only help prevent impact intrusion into the safety cell, but also allow the door to be opened after most impacts.

Engine Support Arm showing “Crumple Zone”



SMART Airbags

Front driver and passenger airbags have been in use with single stage activation since 1986. Once an impact is detected, the airbags are triggered with one specific level of deployment force.

From 1999, BMW developed the SMART airbag which is designed to deploy in 2 stages. There are 4 triggering thresholds which are dependent upon the severity of impact detected, the status of the seatbelts and whether the passenger seat is occupied.

Driver's side SMART Airbag (Rear view)

Passenger side SMART Airbag (Rear view)

The two stage airbags are used for both the front driver and front passenger which allows for a softer cushioning effect when the bags are triggered at lighter impacts.

The 2-stage airbags also employ the "cold-gas" inflation method which differs from the previous single stage airbags. The gas generators contain an inert gas mixture which is released when the airbags are triggered.

Also, the cold gas inflation method was incorporated into the side airbags and the ITS assemblies.

Side Airbags

Since the introduction of MRS, side airbags have been standard equipment. Rear airbags on some vehicles are part of an option package.

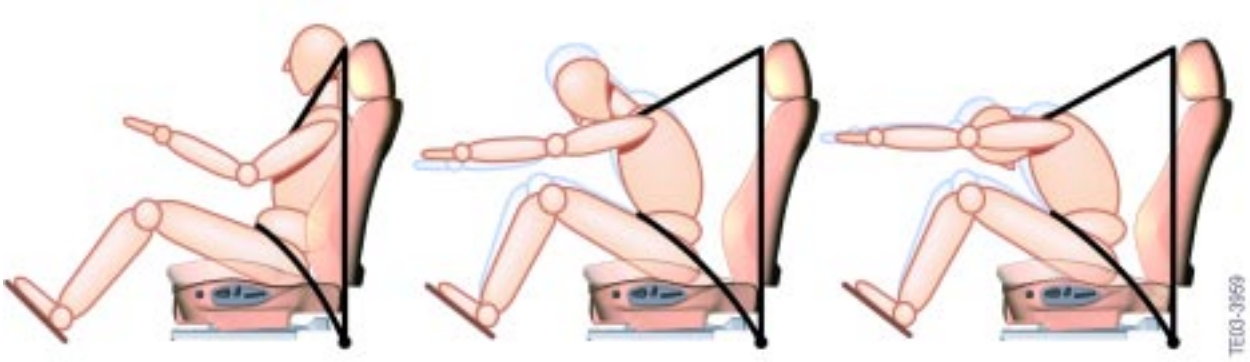
Side airbags are designed to prevent injury to the thorax (chest) region of the occupants.

Side Airbag with Inert Gas Inflation (Rear view)

Seatbelts

Of all of the safety innovations brought forth by the automotive industry, the safety belt is universally recognized as the single most effective safety device. Specifically, the 3-point safety belt provides passengers with safety as well as comfort.

The effectiveness of the 3-point seat belt depends upon the correct positioning of the safety belt on the body.



BMW safety belt systems use an upper anchor point which is height adjustable. In addition, the tensioning mechanisms allow the belt to remain relatively slack to increase comfort while driving.

The seat belt tensioning device is designed to remove slack in the seatbelt during an impact. This increases the effectiveness of the seatbelt and reduces the bio-mechanical load on the passenger.

There are 4 different belt tensioning systems which have been in use on BMW vehicles. The 4 systems are as follows:

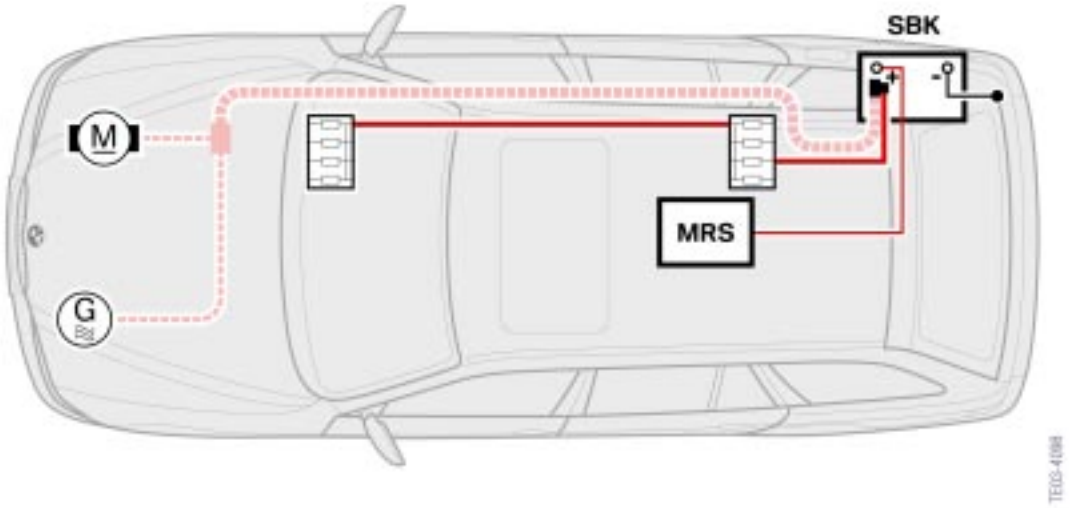
- Pyrotechnic automatic tensioners/end fitting tensioners
- Mechanical seat belt tensioners
- Pyrotechnic seat belt tensioners
- SGS (Seat Integrated Belt System)

More information on the seat belt tensioning systems will be covered in the forthcoming training modules.

Battery Safety Terminal

The Battery Safety Terminal (BST) is designed to minimize the risk of short circuits in severe accidents. The BST protects the B+ cable from the battery to the starter and generator by disconnecting the main connections via a pyrotechnic device.

The rest of the power distribution circuits are protected by various fuses etc. This allows those circuits to remain available for SOS calls, power window and lock operation.



The BST assembly is bolted to the positive battery terminal. It consists of a conventional battery terminal and a contact sleeve attached to the surface of the terminal. The sleeve houses an igniter pellet which contains a small amount of solid propellant.

Upon impact, the propellant is ignited which separates the battery cable from the positive terminal of the battery.

BST - Not Deployed **BST - Deployed**

Once the BST is deployed, it must be replaced. Depending upon application, the entire B+ cable must be replaced or there are repair kits available on some models.

Head Protection System

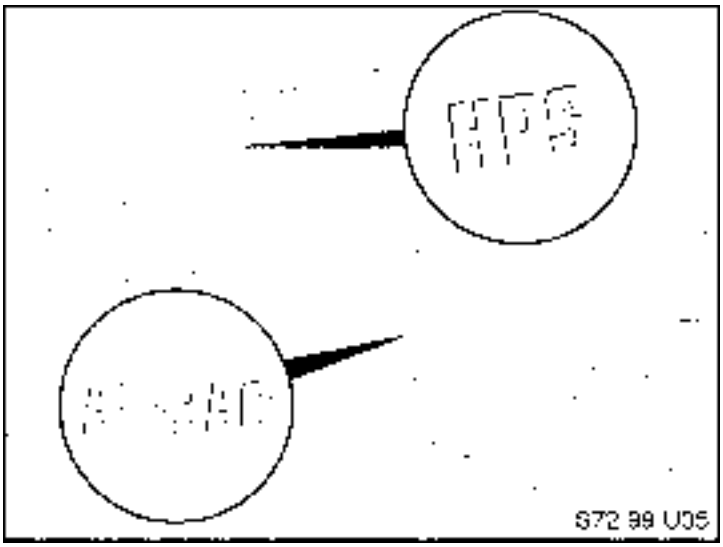
Head injuries account for a large portion of overall accident statistics. To address this statistic BMW added the Head Protection System to complement the side airbags already in use. HPS was developed by BMW to offer increased occupant protection during a side impact and lower the instance of head injuries.

The original HPS, introduced on the E38, consisted of an Inflatable Tubular Structure (ITS) which was mounted in the headliner between the A and B pillars.

The ITS assembly consists of a woven fabric tube containing an inner tube of polyurethane. A gas generator is used to inflate the ITS assembly. When deployed, the ITS increases in diameter and overall length decreases by approximately 100mm. This causes the ITS assembly to emerge from the headliner trim.

The ITS is designed as a sealed unit, unlike an airbag which deflates immediately. The ITS assembly deflates as the gas cools over a period of time, which allows the ITS to remain inflated in the event of secondary impacts.

Rear HPS was introduced later as part of a special rear side airbag option on the E38 and E39. The rear HPS does not use a conventional ITS assembly, but rather an “cushion” type airbag located in the C-pillar. A vehicle with rear HPS can be identified by observing “HPS” in the C-pillar cover.



The Head Protection System was further developed to increase the level of occupant protection. The Advanced Head Protection System was introduced on the E65. It consists of a modified ITS which is now extended by a curtain. There are 2 versions of AHPS available. The first, AHPS I, extends from the A-pillar to the B-pillar and protects the front passengers.

The second version, AHPS II, is part of an option for rear passenger head protection. The AHPS II extends for the A-pillar to the C-pillar to protect front and rear passengers simultaneously. The advantages of AHPS include protection from glass splinters and protruding objects as well as optimized coverage for occupants of all sizes.

AHPS II

AHPS I

Active Knee Protection

The Active Knee Protection consists of a knee airbag located on the front driver and passenger sides of the vehicle. The knee airbag prevent the driver from sliding under the seat belt during an impact. This effect is known as “submarining”. This effect is counteracted by the knee airbag and initiates a controlled forward shift of the upper body.

This increases the effect of the seatbelt and the airbag.

The knee airbag is available on the E65, E85 and E63/64.

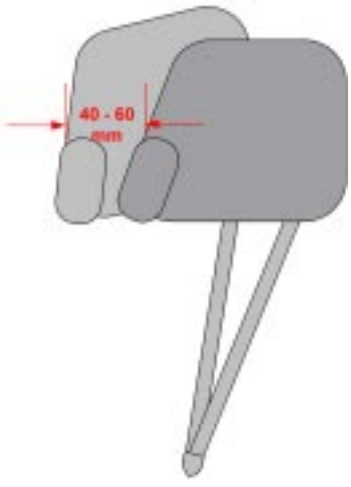
E65 Driver’s Side Knee Airbag

E65 Passenger Side Knee Airbag

Active Head Restraint System (AKS)

In a rear end collision, the risk for cervical vertebrae injuries (whiplash) is high. To prevent this, the objective would be to position the head as close as possible to the headrest. This prevents excessive rearward motion.

On the E65/E66 and E60, the basic seat option only allows for a fixed position between the backrest and head and eliminates the need for the AKS. However, on vehicles equipped with the multi-function seat option, the adjustability of the headrest and backrest allows for the possibility of a large gap between the headrest and the occupants head.



For this reason AKS was developed. The AKS is located in the backrest of the multi-function seat. It is deployed by a pyrotechnic device, similar to an airbag.

Rollover Protection Systems

In order to protect the passengers of a convertible in the event of a rollover, BMW has developed the Rollover Protections System (RPS). Convertible models with RPS include the E36, E46 and E64. BMW roadsters use fixed steel rollover bars, these vehicle include the E52 (Z8), E36/7 (Z3), and the E85 (Z4).

The RPS consists of a set of automatically deployable rollbars which are triggered when the vehicle exceeds certain criteria. This criteria is based on the amount of tilt which is monitored by a rollover sensor.

When an impending rollover is detected, the rollover bars lock into place to provide the necessary head clearance to protect the occupants.

Also, the rollover bars can be deployed by the diagnostic equipment for testing. There is also a reset procedure for each model which is done manually. This allows the bars to be reset in the event of an erroneous deployment.

Summary of BMW Passive Safety Systems

	3 Series				Z4	5 Series				7 Series				6 Series		8 Series		SAV AWD	
	E30	E36	E46	E90/91	E85	E28	E34	E39	E60/E61	E23	E32	E38	E65/66	E24	E63/E64	E31	E52	E53	E83
Cipro	X					X				X				X					
Siemens 2A	X													X					
Siemens 2B		X					X				X					X			
Siemens 2C		X 9/93					X				X					X			
ZAE		X					X					X				X			
ZAE II		X					X					X				X			
MRS		X						X 3/96				X 3/96							
MRSII			X					X 9/97				X 5/97							
MRSIII			X 3/99					X 3/99				X 3/99					X	X	
MRSIV			X 4/01					X 8/01				X 8/01						X 4/01	
MRS 4RD																			X
MRS 5				X															
ISIS													X						
ASE					X				X						X				